UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/233,377	01/18/99	SANDHU G	MI22-1114

021567 MM92/0628
WELLS ST JOHN ROBERTS GREGORY AND MATKIN
SUITE 1300
601 W FIRST AVENUE
SPOKANE WA 99201-3828

EXAMINER	
PHAM, T	

ART UNIT	PAPER NUMBER
2813	14

DATE MAILED: 06/28/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No.	Applicant(s)	
	09/233,377	SANDHU ET AL.	
	Examiner	Art Unit	
	Thanhha Pham	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 April 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *22,24-26 and 45* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *22,24-26 and 45* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15)☒ Notice of References Cited (PTO-892)
16)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
17)☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
18)☐ Interview Summary (PTO-413) Paper No(s). _____ .
19)☐ Notice of Informal Patent Application (PTO-152)
20)☐ Other: .

DETAILED ACTION

Claim Objections

1. Claim 24 objected to because of the following informalities: Claim 24 comprises confusing format of steps of process. Appropriate correction is required.

***Recommendation:*

A method for forming a refractory metal silicide comprisings:

in-situ providing compressive stress inducing atoms into the refractory metal layer during deposition of said refractory metal layer over an underlying silicon containing substrate, the compressive stress inducing atoms being larger than silicon atom of the refractory metal silicide;

annealing the refractory metal layer to form said refractory metal silicide of a first crystalline phase thereby providing the compressive stress inducing atoms within said refractory metal silicide of said first crystalline phase; and

with the compressive stress inducing atoms within said refractory metal silicide of said first crystalline phase, annealing the refractory metal silicide of said first crystalline phase under conditions effective to transform said refractory metal silicide to a more dense second crystalline phase.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 22, 24-26 and 45 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

With respect to claim 22,

line 6, "the silicide", lacking of antecedent basis, should be changed to "the refractory metal silicide"

lines 7-8, "the first phase refractory metal silicide of the first crystalline phase" should be changed to "the refractory metal silicide of the first crystalline phase"

line 10, "said silicide" should be changed to "said refractory metal silicide"

With respect to claim 24,

line 6, "the silicide", lacking of antecedent basis, should be changed to "the refractory metal silicide"

lines 7-8, "the first phase refractory metal silicide of the first crystalline phase" should be changed to "the refractory metal silicide of the first crystalline phase"

line 10, "said silicide" should be changed to "said refractory metal silicide"

With respect to claim 25,

line 6, "the silicide", lacking of antecedent basis, should be changed to "the refractory metal silicide"

lines 7-8, "the first phase refractory metal silicide of the first crystalline phase" should be changed to "the refractory metal silicide of the first crystalline phase"

line 10, "said silicide" should be changed to "said refractory metal silicide"

With respect to claim 26,

line 5, "the silicide", lacking of antecedent basis, should be changed to "the refractory metal silicide"

lines 6-7, "the first phase refractory metal silicide of the first crystalline phase" should be changed to "the refractory metal silicide of the first crystalline phase"

line 9, "said silicide" should be changed to "said refractory metal silicide"

lines 10-11, limitation of "comprising providing the atoms to a concentation within the refractory metal silicide from 10^{16}-10^{22} atoms/cm^3" renders the claim indefinite. It is not clear that "comprising providing the atoms...." is an extra step of providing another atoms within the refractory metal silicide or it is a further condition of "providing compressive stress inducing atoms..." as cited in lines 3-6 in the same claim. Moreover, "the atoms" on line 10, lacking of antecedent basis, should be changed to "the compressive inducing atoms"

With respect to claim 45,

lines 4-5 and 12-13, "providing a compressive stress inducing material proximate the refractory metal" and "comprising providing stress inducing material under the first crystalline phase refractory metal silicide" render the claim indefinite. It is not clear where a compressive stress inducing material should be actually located (above or under the refractory metal) as recited on lines 4-5, "a compressive stress inducing material proximate the refractory metal". Is there any relationship between "providing a compressive stress inducing material proximate the refractory metal" and "comprising providing stress inducing material under the first crystalline phase refractory metal silicide"? In addition, the term "proximate" is a relative

term which renders the claim indefinite. How close is "a compressive stress inducing material" to "the refractory metal" to be considered as proximate?

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

4. Claim 45 is rejected under 35 U.S.C. 102(a) as being anticipated by Kawamura et al [JP 8139056].

Kawmura et al teaches the claimed method of forming a refractory metal silicide comprising steps:

forming a refractory metal (5, Ti, fig 5B) on a a first side of a silicon containing substrate;

providing a compressive stress inducing material (9, fig 5B) under the refractory metal;

after providing the compressive stress inducing material, annealing the refractory metal to form a refractory metal silicide of a first crystal phase (TiSix C49) from the refractory metal and silicon of the underlying substrate, the compressive ; and

annealing the refractory metal silicide of the first crystalline phase to transform the first phase silicide to a more dense second crystalline phase (TiSix C54).

3. Claims 22, 25 and 26 are rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Huang et al [The Influence of Ge-implantation on the electrical characteristics of the Ultra-Shallow Junction Formed by Using Silicide as a diffusion, IEEE Electron Device Letters, Vol 17 Issue 3, March 1996, pp 88-90].

Huang et al, col 1-6, discloses the claimed method of forming a refractory metal silicide comprising steps:

forming a refractory metal silicide (TiSi2, C49, col 2 the Experiment paragraph lines 1-9) of a first crystalline phase;

providing a compressive stress inducing atoms (Ge, col 2 the Experiment paragraph lines 9-10) within the refractory metal silicide of the first crystalline phase; and

with the compressive stress inducing atoms within the refractory metal silicide of the the first crystalline phase, annealing the refractory metal silicide of the first crystalline phase under conditions effective to transformed the refractory metal silicide to a more dense second crystalline phase (TiSi2 C54, col 2 the Experiment paragraph lines 14-20).

With respect to claim 26, concentration of compressive sttess inducing atoms of 10^{16}-10^{22} atoms/cm^3 within the refractory metal silicide does not yield unexpected results.

4. Claims 22, 24-26 are rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Cabral et al [US 5,828,131].

Cabral et al, fig 1-16 col 1-12, discloses the claimed method of forming a refractory metal silicide comprising steps:

in-situ providing compressive stress inducing atoms (refractory metal, e.g. W or/and Ge) into the refractory metal layer (Ti) during deposition of said refractory metal layer over silicon containing substrate, the compressive stress inducing atoms being larger than silicon atom of the refractory metal silicide (Ti-alloy, col 11 lines 38-52, col 3 lines 54-67, col 4 lines 1-6, col 4 lines 56-67);

annealing the refractory metal layer (Ti-alloy) to form said refractory metal silicide of a first crystalline phase (TiSix, C49) thereby providing the compressive stress inducing atoms within said refractory metal silicide of said first crystalline phase (col 11 lines 52-55); and

with the compressive stress inducing atoms within said refractory metal silicide of said first crystalline phase, annealing the refractory metal silicide of said first crystalline phase under conditions effective to transform said refractory metal silicide to a more dense second crystalline phase (TiSix C54, col 11 lines 66-67 and col 12 lines 1-18).

With respect to claim 26, concentration of compressive stress inducing atoms (e.g. W or Ge) 10^{16}-10^{22} atoms/cm^3 in the Ti-alloy does not yield unexpected result.

5. Claim 24 is rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Agnello et al [US 5,608,266].

Angello et al, discloses the claimed method of forming a refractory metal silicide comprising steps:

in-situ providing compressive stress inducing atoms (Pt) into the refractory metal layer (Co) during deposition of said refractory metal layer over silicon containing substrate, the compressive stress inducing atoms being larger than silicon atom of the refractory metal silicide;

annealing the refractory metal layer (Co-alloy) to form said refractory metal silicide of a first crystalline phase (CoSi intermetallic phase) thereby providing the compressive stress inducing atoms within said refractory metal silicide of said first crystalline phase [col 7 lines 1-5]; and

with the compressive stress inducing atoms within said refractory metal silicide of said first crystalline phase, annealing the refractory metal silicide of said first crystalline phase under conditions effective to transform said refractory metal silicide to a more dense second crystalline phase [col 7 lines 12].

6. Claim 22 is rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Kitano et al [US 5,665,646].

Kitano et al, figs 8-16 col 1-6, discloses the claimed method of forming a refractory metal silicide comprising steps:

forming a refractory metal silicide (69, TiSix C49, fig 16) of a first crystalline phase;

providing a compressive stress inducing atoms within the refractory metal silicide of the first crystalline phase, the compressive stress inducing atoms (e.g. As, fig 16) being larger than silicon atom of the refractory metal silicide; and

with the compressive stress inducing atoms within the refractory metal silicide of the the first crystalline phase, annealing the refractory metal silicide of the first crystalline phase under conditions effective to transformed the refractory metal silicide to a more dense second crystalline phase (TiSi2 C54).

[see col 6 for details]

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kimato [US 5,665,646] in the view of Apte et al [US 5,593,924].

With respect to claim 24, in situ providing compressive stress inducing atoms (atoms being larger than silicon atoms) into a refractory metal layer during deposition of the refractory metal layer over an underlying silicon containing substrate and annealing the refractory metal layer to form the refractory metal silicide of the first crystalline phase is a well-known technique for making refractory metal silicide.

With respect to claim 25, Kimato teaches that ion-implanting compressive stress inducing atoms (As) being larger than silicon atoms of the refractory metal silicide is to lower the temperature of transforming TiSix from C49 to C54 crystalline phase by damaging TiSix lattice in an amorphization implanting process. Kimato does not expressively teach using Ge as compressive stress inducing atoms. Apte et al teach that asenic and germanium are equivalent material for amorphizing TiSix for converting TiSix C49 to TiSix C54 [see Apte, col 3-4 particularly col 3 lines 49-56]. It would have been obvious for those skilled in the art apply the teaching of Apte et al in the process of Kimato to use germanium as compressive stress inducing atoms to reduce the temperature of transforming TiSix from C49 to C54.

With respect to claim 26, range of concentration of compressive stress inducing atoms within the refractory metal silicide is considered to involve routine optimization while has been held to be within the level of ordinary skill in the art. As noted in In re Aller, the selection of reaction parameters such as temperature and concentration would have been obvious.

> "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art...such ranges are termed "critical ranges and the applicant has the burden of proving such criticality... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."
>
> In re Aller 105 USPQ233, 255 (CCPA). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

Therefore, one of ordinary skill in the requisite art at the time of invention was made would have used any concentration range suitable to the method Kitano et al in order to optimize the process.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanhha Pham whose telephone number is (703) 308-6172. The examiner can normally be reached on Monday-Thursday 8:00 AM - 7:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bowers Charles can be reached on (703) 308-2417. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-3432 for regular communications and (703) 308-7725 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Thanhha Pham
June 22, 2001

Charles Bowers
Supervisory Patent Examiner
Technology Center 2800